the various lake forms of the long-spined Daphniæ to one species, viz., *Daphnia longispina*. The winter forms of *Daphnia hyalina, Hyalodaphnia* (*Daphnia*) *cucullata* and *Cephaloxus* can not be distinguished from each other and they remain indistinguishable in the spring till the water reaches a temperature of 14° to 16° C. As the temperature rises above this, these indistinguishable forms change in the course of two or three weeks into the slenderer and lighter summer forms which show all the characteristics of the different races to which they belong. In the autumn all return again to the common race form which is found from December until April. The autumn change extends over a longer period than the spring change.

Bosmina coregoni shows a decided seasonal variation while *B. longirostris* shows only an extremely slight one.

The author reaches the conclusion that local and seasonal variations arose during the glacial epoch and are to be considered as the reply of the organism to the greater differentiation in environment; in part at least to the greater claims made by the rising temperature on the floating power of the organism. The return to the arctic form in winter shows that seasonal variation is a condensed summary of the development which the organisms have undergone from the glacial period to the present time.

The long period of time covered by the collections used for this study, and the large amount of material that has been examined, make this a most valuable contribution to this phase of limnological investigations.

C. Juday

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VI., No. 4, August, 1909, issued August 12, 1909, contains the following: "The Spontaneous Oxidation of Cystin and the Action of Iron and Cyanides upon it: The Action of Metals and Strong Salt Solutions on the Spontaneous Oxidation of Cystein," by A. P. Mathews and Sydney Walker. In these two papers various influences which affect the spontaneous oxidation of cystin and cystein are described and the action explained in part. Analogies with cellular oxidations are pointed out. "On the Nature of the Chemical Mechanism which Maintains the Neutrality of Tissues and Tissue-fluids," by T. Brailsford Robertson. The maintenance of neutrality in the blood plasma and tissues is largely dependent upon proteins. The reactions by which it is brought about are explained. "Observations on Uricolysis, with Particular Reference to the Pathogenesis of 'Uric Acid Infarcts' in the Kidney of the New-born," by H. Gideon Wells and Harry J. Corper. Uricolytic ferments could not be demonstrated in human tissues: uric acid deposits in kidneys are not therefore due to failure of such enzymes. "Protein Metabolism in Cystinuria, II.," by Horatio B. Williams and Charles G. L. Wolff. Various metabolic tests carried out on a patient with cystinuria. "The Direct Colorimetric Determination of Phosphorus with Uranium Acetate and Potassium Ferrocyanide," by Robert B. Gibson and Clarence Estes. A convenient quantitative method for total phosphorus in organic compounds. "Notes on the Effect of Shaking upon the Activity of Ptyalin," by Marie M. Harlow and Percy G. Stiles. Adsorption is a factor in explaining the curious observation that some enzymes may be destroyed by mechanical shaking. "The Estimation of Total Sulphur in Urine," by Stanley R. Benedict. Oxidation by copper nitrate very greatly facilitates the estimation of total sulphur.

SPECIAL ARTICLES

SALIENT EVENTS IN THE GEOLOGIC HISTORY OF CALIFORNIA

There are few regions in the world where the records of geologic history are more complete than in California, for every major division is represented by marine sediments, and many of them also by continental deposits. This is made possible by the geographic position between two ancient and persistent bodies of water, the Pacific Ocean, and the Great Basin Sea, which alternately encroached on what is now California, each one supplying that part of the record which the other

omitted. The Pacific Ocean still washes the western shore of California, now encroaching, and now retreating; but the Great Basin Sea is long since dead, and would be buried, were it not for the later uplifts that rear its old sediments in the mountain ranges of the desert region.

In early Cambrian time sedimentation began in the eastern part of California on the western shores of the Great Basin Sea, and kept up, almost without interruption, until the middle of the Jurassic. During this long period the greater part of the state appears to have been above water, although during the Santa Lucia epoch (Paleozoic?), calcareous sediments were laid down in the Coast Ranges, and during the Carboniferous the Great Basin Sea spread westward and southward over much of the region of the Sierra Nevada. In the Permo-Carboniferous, California, although remote from the center of activity, felt the effects of the Appalachian revolution, for an uplift began along the axis of the Sierra Nevada, manifesting itself in great outpourings of volcanic tuffs, which now are preserved as greenstones, showing by their marine fossils that they were deposited in the sea. Further west, the calcareous sediments of the Santa Lucia Mountains were raised above the sea and changed into marbles and schists.

The Appalachian revolution restricted, but did not obliterate, the Great Basin Sea, nor did it confine the relentless advance of the Pacific Ocean, for during the Jurassic marine sediments were laid down along the Coast Ranges, and along the sides of the Sierra. The Franciscan series has preserved this record in the Coast Ranges, and the Mariposa formation in eastern California.

The Cordilleran revolution began in the Great Basin Sea in the middle of the Jurassic, when that body of water, after many vicissitudes, finally went dry, and has never since been covered by salt water, although in later ages Tertiary and Quaternary lakes have been scattered over its dead basin.

This elevation culminated, in late Jurassic time, in the upturning and metamorphism of the Triassic and Jurassic sediments of the Sierra Nevada, and the Franciscan beds of the Coast Ranges. Since that time the Sierra Nevada has been above the sea, subjected to continuous erosion, and there we see the deeper results of metamorphism. The Coast Ranges, on the other hand, have been buried under the later Cretaceous and Tertiary sediments, and the deeper products of metamorphism are little exposed. The glaucophane schists of the Coast Ranges are evidences of rather shallow hydrothermal metamorphism, while the great masses of thoroughly altered rocks and auriferous veins of the Sierra Nevada show the deep-seated action in that region. This explains the fundamental difference between the metamorphic rocks of the two areas, where the phenomenon was contemporaneous, and the rocks affected were similar in the beginning.

During this epoch along the western coast, from Oregon to Lower California, there was much igneous activity, and great masses of serpentine are now seen throughout the Coast Ranges, the results of alteration of the peridotite dykes that were intruded into the Franciscan sediments.

It is probable, also, that the Cordilleran revolution was something more than a mere orogenic disturbance, for it marks a change from the warmth of the Middle Jurassic, with its cycads and reef-building corals, to the cooler epoch of the Upper Jurassic, with its scanty boreal fauna. The Middle Jurassic was of tropical type, from Mexico to Alaska, and uniform up to Franz Joseph Land. The Upper Jurassic, on the other hand, was of Boreal type from the Arctic Region down as far as California, and for a short epoch in the Portland these conditions extended down as far as Mexico.

After this mountain-making epoch near the close of the Jurassic, the sea again encroached on the uplifted area, and the Knoxville sediments were laid down on the western border of the Coast Ranges. The lower Knoxville beds contain a fauna closely related to that of the Mariposa, still with Jurassic types of *Aucella,* and with the same poverty of other animals.

But the upper Knoxville beds, while still retaining reminiscences of the Boreal Region in *Aucella* and a few other forms, show a preponderance of life characteristic of more favorable conditions. *Aucellas* of northerly habit mingle with cephalopods that did not belong in the Boreal Region, and on the nearby land cycads abounded. The line between Jurassic and Cretaceous should be drawn, not at the beginning of the Knoxville, but between the lower and the upper Knoxville beds; the former belonging to the Portland and Aquilonian, while the latter belong to the Neocomian.

With the opening of the Horsetown epoch, the revolution of faunas and floras was complete, the climate had become tropical, and swarms of *Trigonias, Nautilus* and *Ammonites* like those of India and eastern Africa occupied the shallow seas of northern California. These beds were deposited only in a narow strip from Shasta County down to the neighborhood of Mt. Diablo, the rest of the state being above water.

While the Paleozoic and the earlier part of the Mesozoic were characterized by the formation of immense masses of limestone, and the Jurassic and the Knoxville by the deposition of thick beds of shale, the middle Cretaceous inaugurated a sandstone-forming era, which lasted through the entire Tertiary.

During the Upper Cretaceous Chico epoch the climatic conditions and faunal geography remained unchanged, but the sea encroached still farther on the land, reaching the foot of the Sierra Nevada, where, in Butte County, the unaltered and slightly tilted sandstones of the Upper Cretaceous may be seen resting upon the upturned, metamorphosed and eroded rocks of the backbone of California.

By the end of Cretaceous time the subsidence and erosion of the western part of the continent had almost established a connection between the Pacific Gulf in California and Oregon and the old Mediterranean Sea of the Mississippi Valley. The intervening isthmus not covered by salt water was worn down to base-level, and wide expanses of flats were covered with marshes, which eventually formed coal, preserving a very similar flora from the outliers of the Mississippi Valley almost to the Pacific coast. These coal-forming conditions reached far up into Alaska, where almost under the Arctic Circle types of plants flourished that, to-day, could not live in the open north of Mexico.

In Eocene time the climatic and geographic conditions remained the same as in the Upper Cretaceous, but the sea had encroached still farther on the land, and the base-leveling of the backbone of the continent was more complete. The aged rivers began to deposit their loads of sediments, beginning the formation of the auriferous gravels, the first great source of wealth of the Pacific coast.

Tropical conditions still prevailed up as far as Alaska, and coal was still formed abundantly where vegetation is now scanty. If a geologist in western America had first named the geologic systems, the Eocene would have received the name "Carboniferous," for most of the coal on the west coast belongs to that epoch. During the Eocene, also, a temporary connection was established between the Pacific and the Atlantic basins, for in California and Oregon the Atlantic "finger-post of the Eocene," *Venericardia planicosta,* is found along with Pacific types.

Before the Miocene epoch this Atlantic connection had ceased, and the faunas of the later Tertiary were wholly of the Pacific type. The lower Miocene was still warm, for we find in its fauna a *Nautilus* still persisting, and other genera now found only in southern waters. Quiet accumulation of sediments with abundant organic remains, diatoms and radiolaria, was going on in the Coast Range region. From these the petroleum, which has added so much to the wealth of California, was afterwards distilled, in the great disturbance that took place after the close of the Monterey epoch of the middle Miocene.

The vast outpouring of the Columbian lava flow, which covered an area of more than two hundred thousand square miles, including the northeastern part of California, occurred

about the middle of the Miocene, and the Coast Range disturbance was probably a local phase of the same revolution.

In the upper Miocene the climate was no longer subtropical, but warm-temperate and moist, like that of the states bordering the present Gulf of Mexico. Marine animals like those of our time abounded in the waters, but along with them were some southern forms. And on the land elms, walnuts, hickories and laurels flourished, indicating a temperate, rainy climate, moister if not milder than that of to-day in the same region.

In the Sierra Nevada in this epoch there were large rivers, not running swiftly in deep canyons, as they do now, but winding slowly down low grades, overloaded with sediments, the auriferous gravels. These dead rivers, which must have run on a low plain not far above sea-level, are now found high up in the Sierra Nevada, with their channels buried deeply under later lava flows, and warped by later orogenic movements.

In the Pliocene the warm-temperate types of plants have disappeared temporarily, and the salt-water faunas, too, show a change for the worse. The fresh-water Pliocene lake beds also show the influence of a cooler climate, for while many of the fossil mollusca are the same as species now existing in that region, others that are still living are now found only in the Klamath Mountains.

Now the land had begun to encroach on the sea, and the shore was receding westward. The whole west coast was rising, and the salt waters no longer reached to the foot of the Sierra Nevada, nor even to the great valley. But the elevation was not uniform, for valleys in the Coast Ranges that had been cut during the Miocene were filled with sediments during the Pliocene, which was made possible by local subsidence along the coast. The immense deposits of the Great Valley belong partly to this epoch, and partly to the Quaternary, but they are wholly of fluviatile origin. These gravels and silts have been bored into to the depth of three thousand feet in the middle of the Great Valley, and still bed-rock was not reached.

During the Pliocene the Sierra Nevada was elevated again, and the rejuvenation of the streams carried the sediments out of the mountains to the flats of the valley floor, piling up the gravels and clays now known as the Tulare formation. California of that time was very much like California of to-day, with a great mountain range on the east; in the middle a long, broad valley, low-lying, and covered in many places by fresh-water lakes; and on the west, a long, low, narrow mountain range. On the submerged narrow coastal plain, and in troughs parallel to this range, were laid down the marine Pliocene sediments.

About the close of the Pliocene, and in early Quaternary, the elevation of the west coast continued, causing deep canyons to be excavated by the vigorous streams, in the Sierra Nevada, and in the Coast Ranges. This epoch has been called by Professor Le Conte the Sierran epoch. The results of this erosion are still seen in the deep canyons, the most striking scenic features of the Sierra Nevada, but those of the Coast Ranges are now seen only on hydrographic charts, for they are now buried two or three thousand feet under the ocean. This shows that in early Quaternary time the coast stood two or three thousand feet higher than now. The record of that time is purely one of events, for the sediments that were laid down in the bordering sea are now covered by the ocean, and the region that is now above sea-level stood too high for much deposition. The Sierran epoch corresponds to the pre-Glacial or Ozarkian epoch of the eastern states.

Increasing cold accompanied the period of elevation, and this culminated in the Glacial Epoch, in which the Sierra Nevada was covered by a continuous sheet of ice. The ice made its way down sheltering canyons to places that are now 3,500 feet above sea-level, but which then stood several thousand feet higher. This means that in the Glacial Epoch the climate of California was very similar to that which now prevails on the Olympic Peninsula in Washington, for in that region glaciers still come down to 6,000 feet above the sea, the climate is cool and rainy,

Synopsis of Quaternary History of California.

<table>
<tr><td>Recent.</td><td colspan="2">Subsidence epoch of Golden Gate and other bays.</td><td colspan="3">Invasion of Golden Gate River System by tide water and formation of the harbors of the West Coast. This subsidence has been going on until very recent time, for Indian shell mounds around the Bay of San Francisco are partly flooded.</td></tr>
<tr><td rowspan="4">Quaternary.</td><td>Terrace Epoch.</td><td>Terrace.</td><td colspan="3">Period of uplift and scouring out the channels filled during the San Pedro epoch, forming terraces in the fluviatile sediments of San Benito Valley, and nearly all the valleys of the Coast Range. The youngest (lowest) terraces of the San Pedro truncate the upper San Pedro beds and are later than they. The older (higher) wave-cut terraces of the West Coast probably date back to the Sierran epoch.</td></tr>
<tr><td>Upper San Pedro.</td><td rowspan="2">Champlain.</td><td rowspan="2">Epoch of depression along the coast. Coast stood 300–700 ft. lower than now.</td><td>Warm water. Marine fauna.</td><td rowspan="2">Epoch of filling preexisting valleys with gravels and other fluviatile sediments. Seen in the Salinas Valley, Santa Clara Valley, San Benito Valley and the Great Valley.</td></tr>
<tr><td>Lower San Pedro.</td><td>Cold water. Marine fauna.</td></tr>
<tr><td>Sierran Epoch. Probably longer than all the rest of the Quaternary.</td><td>Pre-Glacial. | Glacial.</td><td colspan="2">Period of elevation of the West Coast, forming the great canyons off the Sierras and the submerged canyons of the coast. A period of no marine sediments (now exposed). In part contemporaneous with the Glacial Epoch, for the glaciers of the Sierra Nevada came down some of the canyons.
The West Coast then stood about 3,000 ft. higher than now, as shown by the submerged Monterey Bay canyon at a depth of 3,000 ft.</td><td>The principal terracing along the coast took place at this time, and also the Channel Islands were connected with the mainland, as shown by the Santa Rosa Mammoth.</td></tr>
<tr><td>Pliocene.</td><td>Merced beds.</td><td></td><td colspan="3">Period of depression and filling of troughs with marine Pliocene sediments, and formation of great Pliocene lakes above sea level.</td></tr>
</table>

and the forests consist almost entirely of conifers.

During the period of elevation the Channel Islands off the coast of southern California were connected with the mainland, allowing mammoths to make their way across on dry land. The channel was then a gulf, not unlike the present Gulf of California, and may appropriately be called the Santa Barbara Gulf.

After the Glacial Epoch had passed, there came another era of subsidence, but this time on a small scale, affecting only the immediate shore-line, which stood for a time from three to seven hundred feet lower than now. During this period were accumulated the marine San Pedro beds, known chiefly in the Santa Barbara Gulf. At first the water was a little colder than at present, allowing marine life now characteristic of Puget Sound to flourish as far south as San Pedro. Then it became warmer, and, for a short time, species that today can not live north of Lower California made the Santa Barbara Gulf their home. This history is remarkably like that of New England, where a warm Champlain epoch of depression followed the Ice Age.

After the San Pedro epoch there came on the west coast a renewed elevation, causing the streams to terrace the alluvial deposits that had filled the lowered valleys in the preceding epoch. This, too, has its counterpart in the Terrace epoch of New England. This time has left us no marine record, but only terraces on the streams, and along the shore.

The last phase in the physical history of the west coast is the recent subsidence that allowed the sea to encroach on the river valleys, forming the Bay of San Francisco, and other bays along the coast. This has been going on almost into modern time, for Indian shell mounds, apparently made by the same race

that still exists in California, have been flooded by the continued subsidence of the Bay of San Francisco.

It is remarkable and little appreciated that the physical history of the Pacific coast should be so like that of the eastern coast of America. On both sides we have the preglacial, Sierran or Ozarkian, elevation of the land, and erosion of deep canyons; the southward advance of the glaciers; the Champlain, or San Pedro, subsidence and amelioration of the climate; the Terrace elevation and moderate erosion; and the recent subsidence that made the fiords of New England and of Puget Sound, the gentler bays of California and Oregon on the west, and the sounds of the Atlantic states on the east. On both sides of the continent submerged canyons run out to sea, marking the course of drowned rivers of early Quaternary time, now forming channels of navigation, making possible the maritime commercial centers of the east and the west.

JAMES PERRIN SMITH

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE seventy-ninth annual meeting of the British Association for the Advancement of Science was held at Winnipeg, Canada, August 25 to September 1, under the presidency of Sir J. J. Thomson, professor of experimental physics in the University of Cambridge. This was the fourth time only in the long history of the association that it met outside of the British Isles; the other three being Montreal 1884, Toronto 1897, and South Africa 1905. The westward movement of the Canadian meetings and the increasing frequency of the meetings outside of the British Isles afford much food for thought, and the former was the source of many comments as regards the rapid development of central Canada and of Winnipeg in particular.

The inaugural meeting, held in the Walker Theater on the evening of August 25, was opened by the rising of Professor Geo. Carey Foster, who asked Major MacMahon, the general secretary, to read a letter from the retiring president, Francis Darwin, who was unable to be present. After the reading of this letter the president-elect, Sir Joseph Thomson, read his inaugural address, dealing with a wide range of educational matters in a very scholarly manner. His expressed wish that the interchange of students between the British Isles and Canada should increase was received with loud applause.

After this address Mayor Evans, of Winnipeg, welcomed the association and delivered a very interesting address, which was in part as follows:

"To the men and women who have earned by their services the position of leaders in the work of science and to the association which is devoted to the encouragement of scientific investigation and the spread of scientific truth, we would do all honor and to them we extend a hearty welcome to our city and to our country. To those who are present from the nations of continental Europe and from the United States we offer a particular welcome to this portion of the British empire, for beyond the value of their contributions to the success of this meeting from the scientific standpoint, their consent to participate in the work of this association must strengthen among the nations the realization of unity of interests in the fundamental concerns of life, which should, and we believe will, tend more and more to lessen the causes of serious dispute.

"But cosmopolitan as it is and must be in its spirit, we do not forget that this is the British Association for the Advancement of Science, an institution of our own empire, with its origin and home in the heart of that empire. To it, as an evidence of the vitality of the higher life of the empire and as a most important agency in the improvement of the material conditions of the British peoples, as well as in the stimulation and discipline of their rational powers, we give a welcome that draws a quality from our common patriotism. We have by custom no ceremony that bestows the freedom of the city, but with all the cordial significance of that formality we bid you to be free in Winnipeg. Our city is such as you may see it. The observations of a day will, however, give you only the statical facts of the city, whereas the real Winnipeg is essentially a study in dynamics. It has trebled its population in the past eight years and is increasing to-day in that ratio. Literature is distributed to its citizens in forty-five languages and dialects and immigrants are daily coming from all quarters of the earth. It is the principal city of central and western Canada, so situated between the Great Lakes to the north and the international boundaries that all the traffic in Canada between the east and the west does and must pass through it. Its business is expanding in proportion to the remarkably